Japan

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Japan is a highly industrialized nation whose welfare is very dependent on a reliable fuel supply from overseas.

1. Structure of the energy supply by energy sources

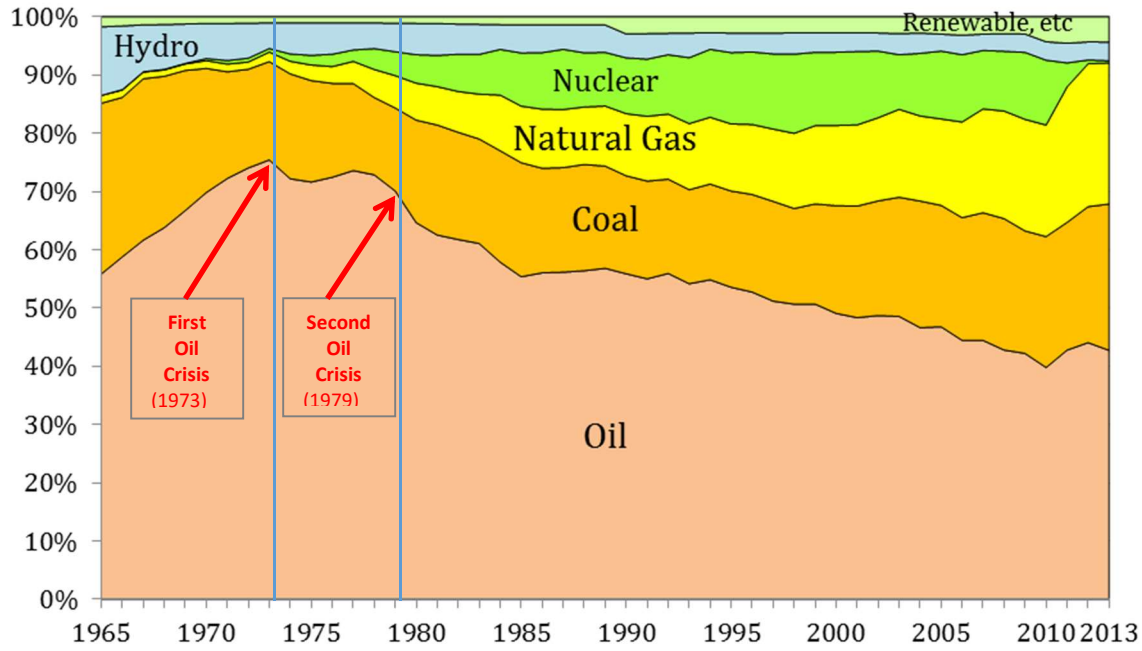
When reviewing energy and environment policies, it is very important to take a holistic view of the various factors in each country, such as the stage of economic development, supply/demand balance of energy, availability of local fossil fuel and renewables, applicability of nuclear power, geographical constrains affecting energy supply systems, credit rating and the level of technology of local industries.

Table 1: Energy self-sufficiency in Japan

Year	1960	1970	1980	1990	2000	2005	2010	2011	2012	2013
Self-efficiency (%)	58.1	15.3	12.6	17.1	20.4	19.3	19.9	11.1	6.3	6.0

Source: Energy White Paper 2015, Agency for Natural Resources and Energy, METI

Figure 1: Historical change of primary energy in Japan



Source: Energy White Paper 2015, Agency for Natural Resources and Energy, METI

Note: "Renewables etc." consists of solar power (0.1%), wind power (0.2%), geothermal heat (0.1%), and biomass (3.3%) in 2013

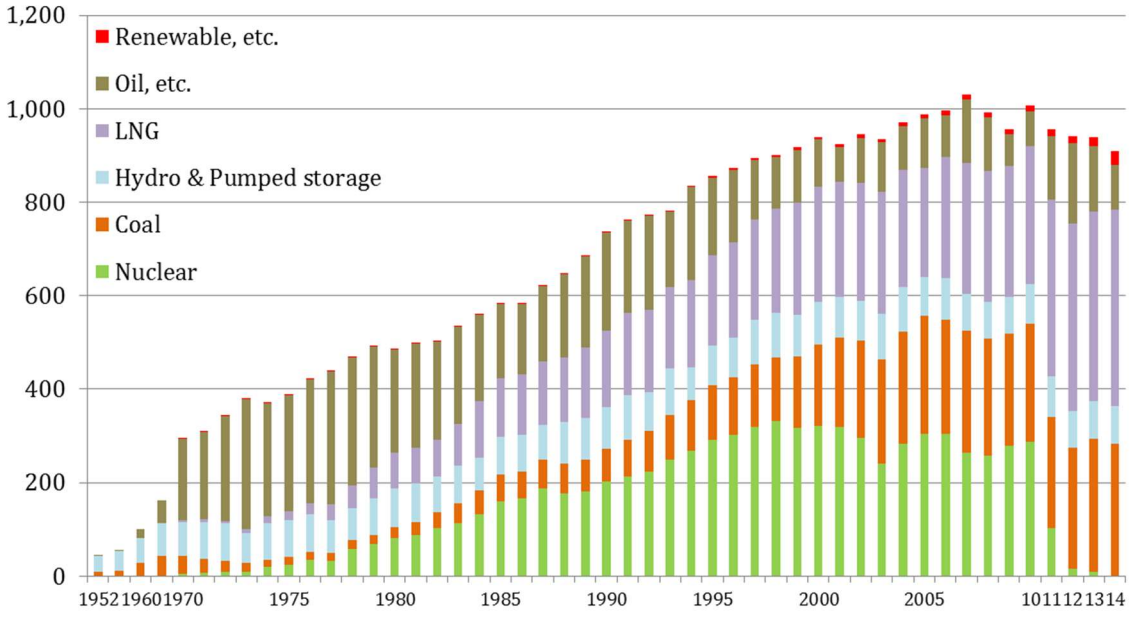
Japan is an energy-poor country that depends substantially on imports to meet its energy resources. The self-sufficiency rate of total primary energy in Japan has been extremely low. It was 6.0%[1] in 2013, including nuclear power. The economy relies heavily on the Middle East for oil and natural gas supplies.

In response to the two oil crises in the 1970s, Japan as its main policy implemented a national energy policy to reduce its dependence on oil. Japan has aggressively diversified its electricity portfolio from oil to nuclear, coal-fired and LNG-fired power generation in parallel with promoting high energy efficiency in the industrial/business and residential sectors.

Since each electric power source has its own pros and cons., it is extremely important to establish a balanced and sustainable energy portfolio according to a so called "3E+S" principle, i.e. energy supply stability, economic efficiency, environmental protection and safety. In the 2000s, a result of the diversification policy, Japan achieved a well-balanced energy mix portfolio.

After the Fukushima nuclear accident in 2011, all nuclear power plants, that accounted for almost 30% of electricity generation, were suddenly forced to stop its operations. Consequently, coal-fired and LNG-fired power plants have significantly increased generation to alleviate the impact of this energy crisis and confirms the importance of maintaining a diverse energy portfolio to ensure energy security.

Figure 2: Development of Electricity mix in TWh



Source: Energy White Paper 2015, Agency for Natural Resources and Energy, METI

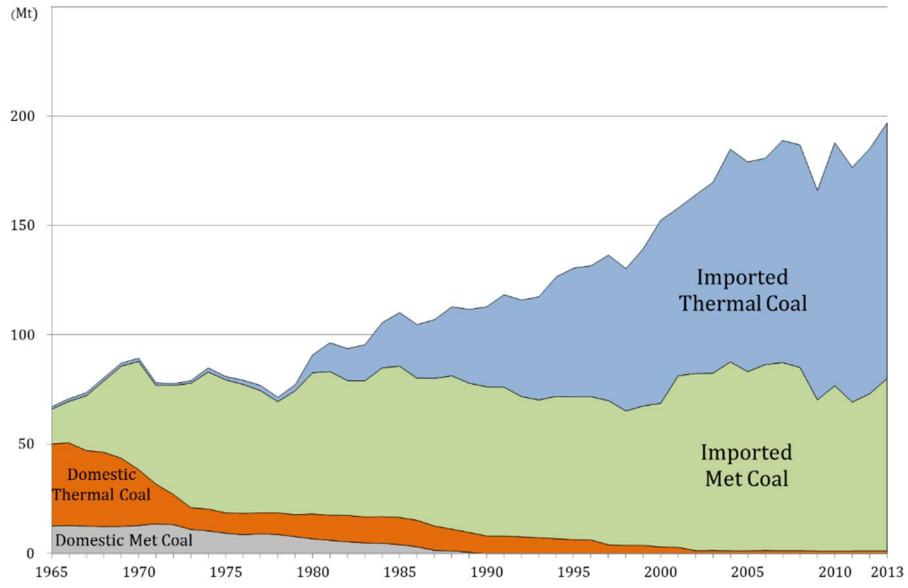
[1] Estimated figure.

This also raised awareness that diversification of energy sources such as nuclear, fossil fuels and renewable energy is not only important, but also for supplier countries, areas, companies, qualities, types of sales/purchase contract, etc. Successful energy diversification is multi-dimensional.

2. Coal supply in 2014

Through the 1950s and 1960s, domestic coal production was the main source of energy supply. However, demand for the local supply of coal decreased rapidly as a result of the revolutionary shift in fuel use from coal to oil in the 1960s. Consequently, costly domestic coal production decreased dramatically and by 2014[2], Japan produced only 1.3 Mt of coal which was almost exclusively supplied to electric power companies.

Figure 3: Production and imports of coal in Japan (1965-2013)



Source: Energy White Paper 2015, Agency for Natural Resources and Energy, METI

After the oil crises, Japan promoted a national energy policy which reduced its dependence on oil and began to adopt nuclear power, imported LNG and coal. Domestic coal has gradually been replaced with imported coal which ensured a stable supply and lower cost since the mid-1970s. In 1981, Matsushima Power Plants (2x500MW), the world's first full-scale imported coal-fired power plants, started its operation. After the first success, Japanese utilities built a series of developments of large-scale coal-fired power projects fuelled by imported coal. The share of coal-fired power generation in Japan has increased from 4.5% in 1980 when domestic coal was mainly

[2] Please refer footnotes of "Attachments Japan".

used to nearly 30% at present. Imported coal now plays an essential role in the Japanese electricity mix offering a stable energy supply and lower electricity costs.

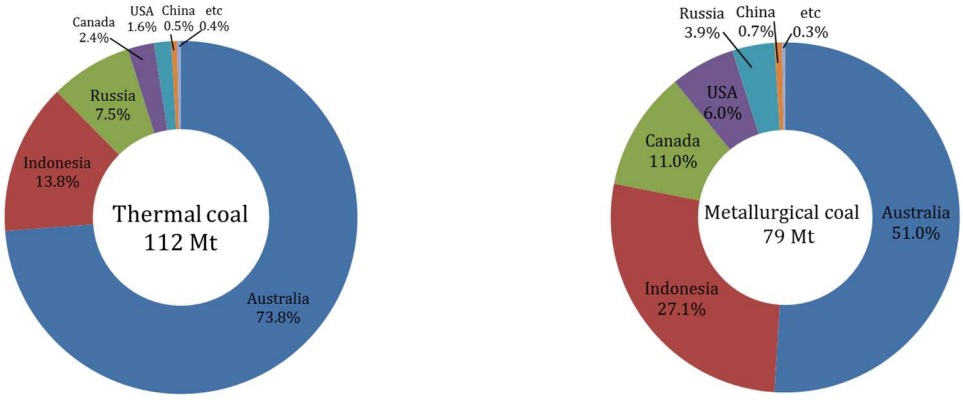
Japan imported 190Mt of coal in 2014, of which thermal coal accounts for 130Mt. As a result, Japan is the third largest importer of thermal coal in the world. Major supply sources are Australia and Indonesia accounting for about 90% of the total thermal coal imports. Since the early 1980s, several consumers have taken a long-term view and have invested in new thermal coal mines abroad in order to secure stable supply.

Increasingly global energy markets are closely linked, changes in energy demand/supply in one region may instantly affect other regions. This increases the challengers for coal importers who need to quickly respond to supply issues quickly through a combination of multiple coal procurement and transportation strategies in order to ensure secure stable and competitive coal supply. A flexible worldwide coal market is a key element which contributes to the energy security of Japan who relies heavily on fuel imports.

Such flexibility and liquidity in the markets will become even more important with the deregulation of the power market starting in 2016.

A reliable close relationship between exporting countries and importing countries is indispensable for energy security. For example, private sectors including the energy industry in Australia and Japan have held the Australia-Japan Joint Business Conference annually since 1962. The coal sectors in both countries have also held the Australia-Japan Coal Conference biennually. These regular conferences contribute to a close understanding between both parties with the long-term aim of promoting coal trade.

Figure 4: Imports of coal in Japan (2014FY)



Source: Energy White Paper 2015, Agency for Natural Resources and Energy, METI

3. Role of coal in the energy supply market

Thermal coal is used mainly for power generation in Japan. Power generation consumes almost 70% of thermal coal and the rest is used in the general industry including cement production.

Coal-fired power plant is rated highly for its stable supply and cost-competitiveness and recognized as an important base-load power source. Since the oil crises, coal power generation has expanded its share and contributed to the base energy supply in Japan along with nuclear power.

After the Fukushima nuclear accident in 2011, LNG-fired and oil-fired power plants had to increase availability in order to make up for the loss of nuclear power plants. Coal-fired power plants were already operated at almost full load, as a result large volumes of LNG and oil were imported. Mandatory electricity consumption reductions were also implemented. As a result, LNG-fired power generation accounted for 46% of Japan's power generation in 2014 (an increase of +19% from 2010).

As a result, imports of LNG and oil increased significantly in volume and value. This increase led to a large trade deficit in Japan in recent years and a rapid increase in LNG prices in the Asia Pacific market.

As a result, the average electricity price rose by approximately 25% for households and a 40% for industries.

Figure 5: LNG import in Japan

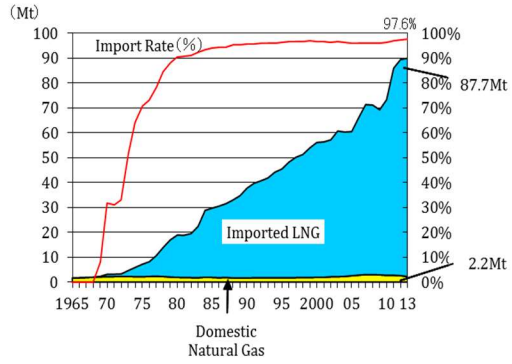
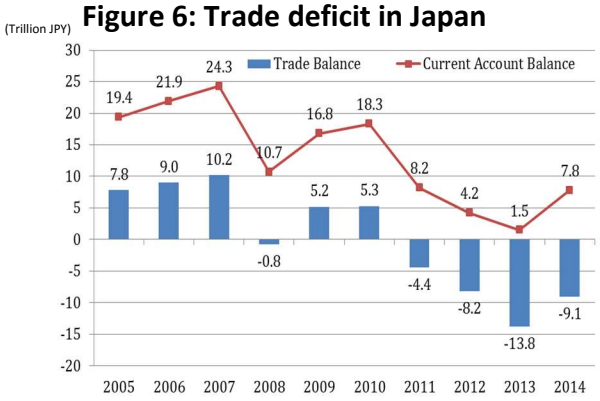


Figure 6: Trade deficit in Japan



Source: Energy White Paper 2015, Agency for Natural Resources and Energy, METI

Since the Fukushima nuclear accident, all nuclear plants ceased operations, coal-fired power generation now plays a more important role as a cost-competitive and stable supplier of electricity. In response, the Japanese Government drafted and announced the 4th Strategic Energy Plan in April 2014, in which coal is designated as an important energy source. (Please refer Appendix, an abstract of the 4th Strategic Energy Plan)

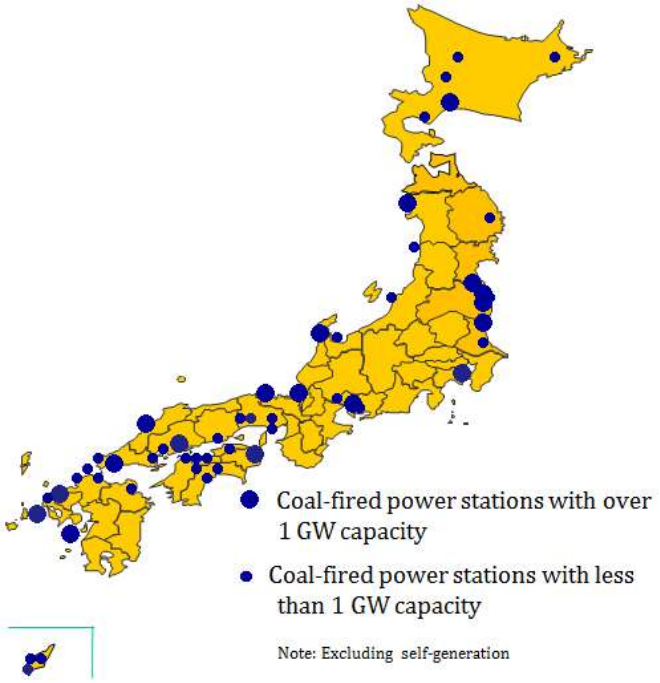
Due to the uncertainty of nuclear power generation and in response to the liberalization of electricity market starting on April 1, 2016, electric power companies and other new players are planning to build a number of new coal-fired power plants. Over 20 coal-fired power plants with 15 GW in total installed capacity have already been announced. Although most of these plants are still in the early development stage, they are targeted to start operation in the 2020s.

4. Coal supply infrastructure

Japan is an island so all imported coal needs to be shipped into the country. Large-scale consumers including electric power companies and steel mills organize dedicated vessels for the long-term stable transportation of coal in addition to the use of flexible COA in the freight market. *(COA: Contract of Affreightment)*

In Japan, large-scale consumers of coal principally also locate their plants near the coast. Coal-fired power plants are scattered across over 50 locations nation-wide.

Figure 7: Coal-fired power stations in Japan (As of Dec. 31, 2014)



Source: J-POWER

In general, coal vessels arrive directly at a customer's exclusive unloading berth. Still there are more than 10 coal stock yards across the nation which are available for temporary stocks of coal if a customer's berth cannot accommodate large vessels. Through blending of various coals, such coal stock yards contribute to a flexible and stable supply of coal with quality needed by the customer.

In contrast to the dynamic coal supply chain, imports of LNG into Japan require a unique value chain including liquefaction, LNG shipping and a regasification processes with huge investments. As a result, most LNG sales are still based on long-term contracts including a so-called "take or pay" clause, although trades with short-term contracts are gradually increasing in recent years. In addition, prices are linked with oil in most cases. Domestic pipeline networks for natural gas haulage in Japan remain very vulnerable.

5. Relationship between technology and security of supply

Due to the expensive and long coal supply chain, Japan has promoted the development of highly-efficient coal-fired power plants with the purpose of efficiently using coal and also protecting the environment. Ultra-supercritical (USC)/Supercritical (SC) plants make up over 70% of the 43 GW of coal-fired installed power plants in the power industry. The average heat efficiency (LHV, net) of all coal power plants is 42%. The average capacity factor is more than 80%.

After 2000, most of new large-scale coal-fired power plants in Japan were built using world-leading USC with 25Mpa/600 degrees centigrade steam conditions or higher. In addition, some of ageing subcritical coal and oil-fired power plants are scheduled to be replaced with the latest high-efficiency USC coal-fired power plants.

Figure 8: Photo of Isogo Power Station

Item	No.1 Unit	No.2 Unit
Output	600MW	600MW
Fuel	Overseas Coal	Overseas Coal
Coal Storage	Indoor Coal Silo	Indoor Coal Silo
Main steam pressure	25MPa	25MPa
Main steam temperature	600℃	600℃
Recycling reheat steam temperature	610℃	620℃
Nitrogen oxides	20ppm	13ppm
Sulfur oxides	20ppm	10ppm
Soot and dust	10mg/㎥N	5mg/㎥N

Source: J-POWER

Japan has committed further to the R&D of clean coal technologies, such as A-USC, IGCC, IGFC and CCS.

With government support Advanced USC (A-USC) that has more than 30MPa and 700℃ steam are now in development with a target of being technically demonstrated in 2016.

IGCC is classified into two types by gasification methods – air-blown and oxygen-blown types. A demonstration plant of air-blown IGCC (250MW) began operations in 2007 in Japan. The plant achieved the longest continuous operation time for a IGCC plant in the world in 2013. After this demonstration stage, two commercial units of air-blown IGCC (2 X 540MW) are expected to start construction in 2016.

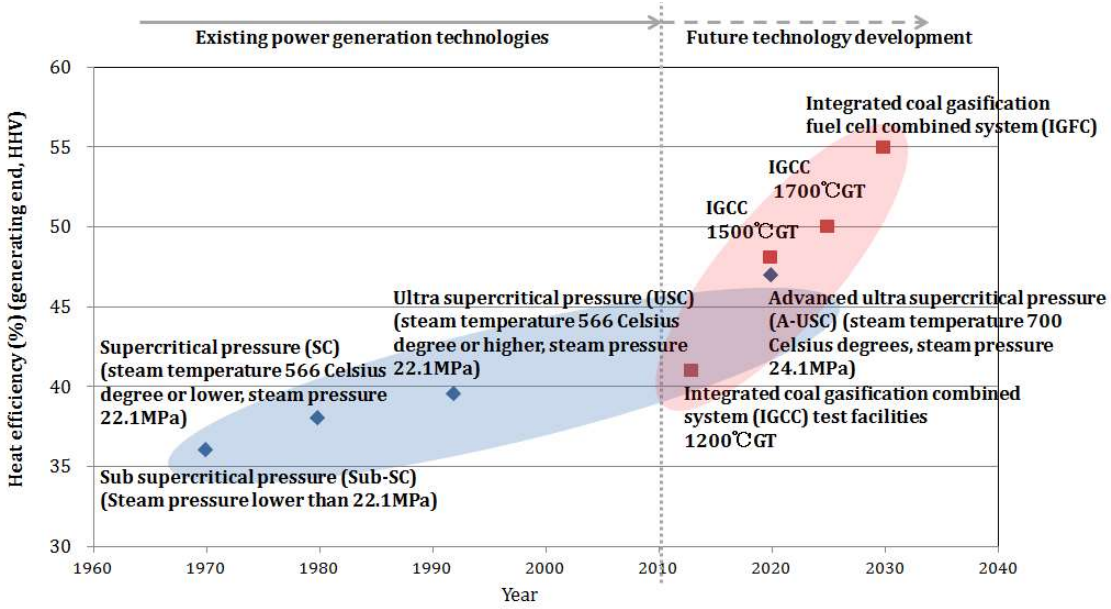
A demonstration plant of oxygen-blown IGCC (166 MW installed capacity) which could attain an even higher efficiency is under construction relying on support from a government fund and is scheduled to start operations in March 2017. The program is further scheduled to incorporate Fuel Cell (IGFC) and CCS at 2nd and 3rd stage.

Deployment of high-efficiency technologies plants such as USC, A-USC, IGCC and IGFC contributes to reducing coal consumption per unit of power generated. IGCC also paves the way for the use of more low-rank coal with low ash fusion temperature that is suitable for gasification.

These technologies will greatly contribute quantitatively and qualitatively to securing energy supply.

A CCS demonstration project for carbon storage will start actual storage in 2016 in Hokkaido, and the government is planning further R&D programs to make CCS commercial.

Figure 9: Efficiency improvement of coal thermal power generation



Source: Agency for Natural Resources and Energy, METI

In addition, coal-fired power generation will continue to improve its operational flexibility. Improvements in minimum load and load change speeds, in order to support increased renewable energy availability is also important for enhancing energy security as well as protecting the environment.

Since 2002, Japan has transferred knowledge from its underground mining technologies to China, Vietnam and Indonesia as a part of international cooperation programs. This helped these countries enhance their production of underground coal mine more efficiently, environmentally and safely and in turn, contributing to the stable supply of coal.

6. Government energy and climate policy and intergovernmental treaties – expected impacts on coal

In April 2014, the Japanese Government announced the 4th Strategic Energy Plan, which is the first revision of the Plan post Fukushima. The new plan aims 1) to realize a robust, practical and multi-layered energy supply structure, 2) to create a flexible and efficient demand and supply structure by electric market reforms (deregulation), and 3) to improve the self-sufficiency energy ratio by developing and introducing domestic resources etc.

In the Plan, coal is revaluated as an important base load power in terms of its stability and cost effectiveness, and the following strategies were proposed:

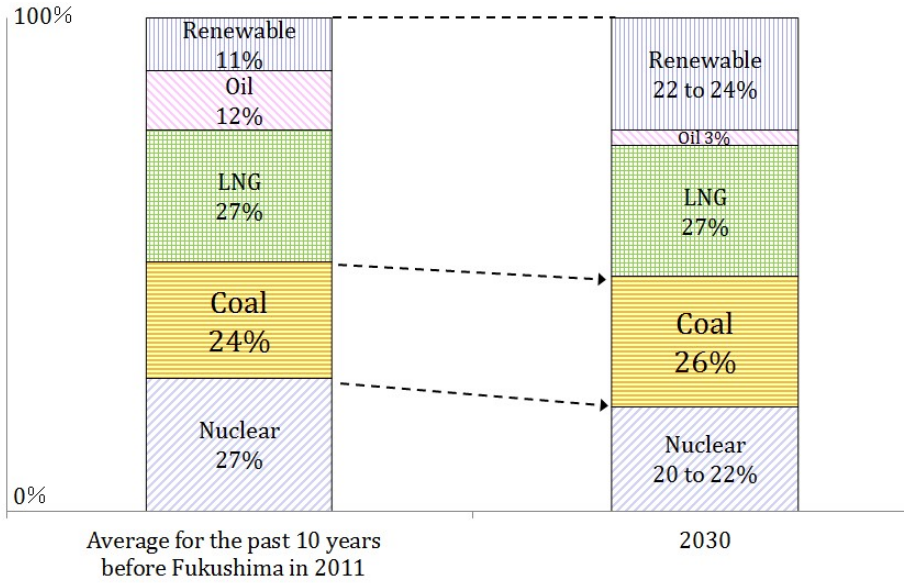
1. To secure stable coal supply with low cost, promote diversification of coal supply and expand the use of low-quality coal;
2. To promote the use of coal compatible with the environment, enhance technology development for highly efficient use and low carbonization, such as A-USC, IGCC, IGFC and CCS;
3. To contribute to a reduction in the global environmental impact, promote overseas deployment of Japanese low-carbon coal technologies

Energy and environment policy of the Japanese government is based on how to achieve the balance of the 3E + S (Energy Security, Economic Efficiency, Environment Protection and Safety). Particularly in Japan, which relies on energy resources from overseas, it is imperative to have a well-diversified energy portfolio. Thus, the government concludes that coal plays an important role as a base load power supply source with the benefit of very low cost and stable supply.

By strengthening R&D of clean coal technologies and their wide deployment overseas, the Plan stated that Japan can contribute to the mitigation of energy and environment issues on a global scale.

(Please refer to the Appendix, for an abstract of the 4th Strategic Energy Plan)

Figure 10: Electricity Generation mix in 2030

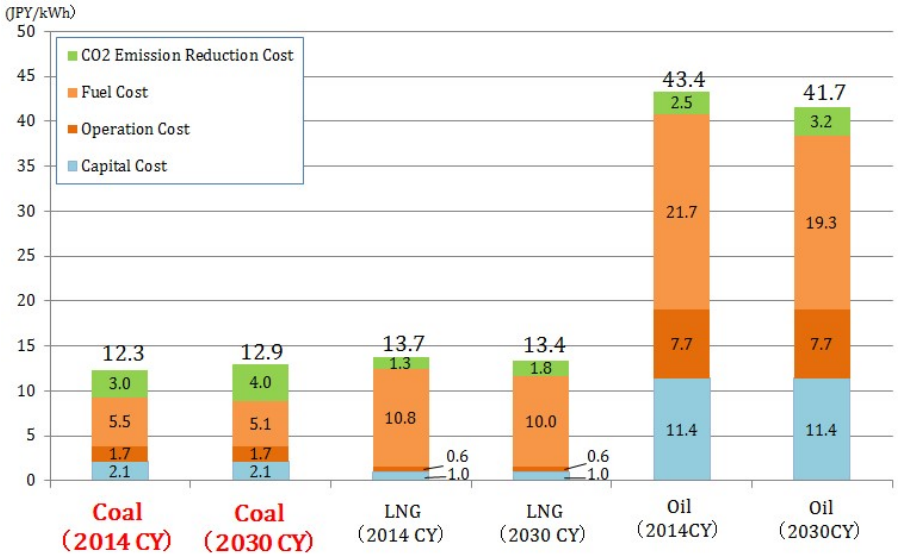


Source: Developed from Long-term Energy Supply and Demand Outlook, Agency for Natural Resources and Energy, METI

In April 2015, the Government also announced a target for the future electricity mix in 2030. In the plan, coal-fired power generation is expected to remain an important base load supply source and account for 26% of Japan's total power generation in 2030[3]. As a part of electricity mix evaluation process, the government made comprehensive analyses of the new plant generation costs from each energy sources in 2014 and 2030.

[3] On June 16th 2015, in light of a report that was compiled by the Long-term Energy Supply and Demand Subcommittee of the Strategic Policy Committee of the Advisory Committee for Natural Resources and Energy, the Ministry of Economy, Trade and Industry (METI) has approved the Long-term Energy Supply and Demand Outlook pursuant to the policies of the Strategic Energy Plan.
http://www.meti.go.jp/english/press/2015/0716_01.html

Figure 11: New plant generation costs in 2030



Source: Developed from 2015.5.26 report issued by working group of generation cost review, Agency for Natural Resources and Energy, METI

On July 17th 2015, the Government of Japan submitted its GHG emissions reduction target for 2030 to the UNFCCC, in which Japan will reduce GHG emission by 26.0% by FY 2030 from its emission level in FY 2013 (-25.4% from FY 2005 emission).[4]

Figure 12: GHG emissions reduction target for 2030 in Japan

	Compared with 2005	**Compared with 2013**
Energy related CO2	-20.9%	**-21.9%**
Other GHG	-1.8%	**-1.5%**
Forest sink measure, etc.	-2.6%	**-2.6%**
GHG emission reduction	-25.4%	**-26.0%**

Source: Developed from Press Release of INDC submission by MOFA

7. Summary and main messages

As a country heavily relying on energy imports, Japan has promoted energy diversification to achieve energy security.

With the energy crisis after the Fukushima nuclear accident and impending deregulation of electricity and gas market in Japan, diversification and the flexibility of energy supply plays an

[4] http://www.mofa.go.jp/press/release/press4e_000811.html

even more crucial role that has to be further accelerated to cope with growing uncertainties in the future.

Coal-fired power generation will continue to play an important role as an indispensable pillar for energy supply diversification in Japan, as long as coal is supplied economically and stably.

On the other hand, reduction of CO_2 emissions is also a critical issue. One approach to tackle this issue is the development of clean coal technology including further improvements in the thermal efficiency of coal-fired power plants and CCS.

Like the contribution of technology in the development in shale gas exploration, the progress of technology promotes energy diversification and energy savings, which links with enhancing energy security. Coal-fired power generation has huge potential for further technology developments such as A-USC, IGCC, IGFC and CCS. Japan is willing to play a leading role in Clean Coal Technologies globally.

Transfer of clean coal technologies centering on high-efficiency low-emission (HELE) coal-fired power generation to other countries will also greatly contribute to not only world economic development and the reduction of CO_2 emissions but also energy security through more efficient use of coal.

Energy Production in Mtce in 2013FY

Hard coal	**0.00***[5]
Brown coal	**0.00**
Crude Oil	**0.82**
Natural Gas	**4.40**
Renewable energies	**31.00**
Other energies	**25.65**
Total	**61.87**

Energy Imports in Mtce in 2013FY

Hard coal	**181.31**
Brown coal	**0.00**
Crude oil and oil products	**341.93**
Natural gas	**164.62**
Other energies	**0.00**
Total	**687.86**

Energy Exports in Mtce in 2013FY

Hard coal	**1.22**
Brown coal	**0.00**
Crude oil and products	**40.11**
Natural gas	**0.00**
Other energies	**0.00**
Total	**41.33**

Primary energy consumption in Mtce in 2013FY

Hard coal	**180.05**
Brown coal	**0.00**
Oil	**306.30**
Natural gas	**173.52**
Nuclear energy	**2.73**

[5] Although there are small number of domestic hard coal production in Hokkaido, northern part of Japan, but primary energy production of hard coal is statistically shown 0.0, because of the statistical processing.

Hydro Power	**22.92**
Other renewable energies	**31.90**
Other energies	**0.00**
Total	**716.52**

Hard coal in Mt in 2013FY

Surface production Underground production	**1.25**
Imports	**195.59**
Exports	**0.00**
Total supply	**196.84**
Domestic consumption	
• Power generation	**83.70**
• Steel industry	**66.10**
• Cement industry • Chemical industry • Fertilizer industry • Households and other consumers • Others	**34.12**
Total consumption	**183.92**

Brown coal in Mt in 2013FY

Surface production Underground production Imports Exports Total supply	**None**
Domestic consumption • Power generation • Steel industry • Cement industry • Chemical industry • Fertilizer industry • Households and other consumers • Others Total consumption	**None**

Power capacity (net) in GW at 31 December 2014

Hard coal	**41.28**
Brown coal	**0.00**
Natural gas Oil	**102.15**
Nuclear energy	**44.26**
Hydro Power	**45.40**
Wind	**0.03**
Solar PV	**0.07**
Geothermal	**0.47**
Bioenergy	**0.00**
Others	**0.00**
Total	**233.66**

Power generation (gross) in TWh in 2014

Hard coal	**287.38**
Brown coal	**0.00**
Natural gas	**438.07**
Oil	**114.99**
Nuclear energy	**0.00**
Hydro power	**80.98**
Wind	**4.94**
Solar PV	**17.23**
Geothermal	**2.56**
Bioenergy	**5.48***[6]
Others	**13.80**
Total	**959.95**

[6] The generation data of Bioenergy is included in the thermal generation data (i.e. Hard coal, Brown coal, Natural gas, Oil) in Japan, so the total is not equal to the sum of each power generation.

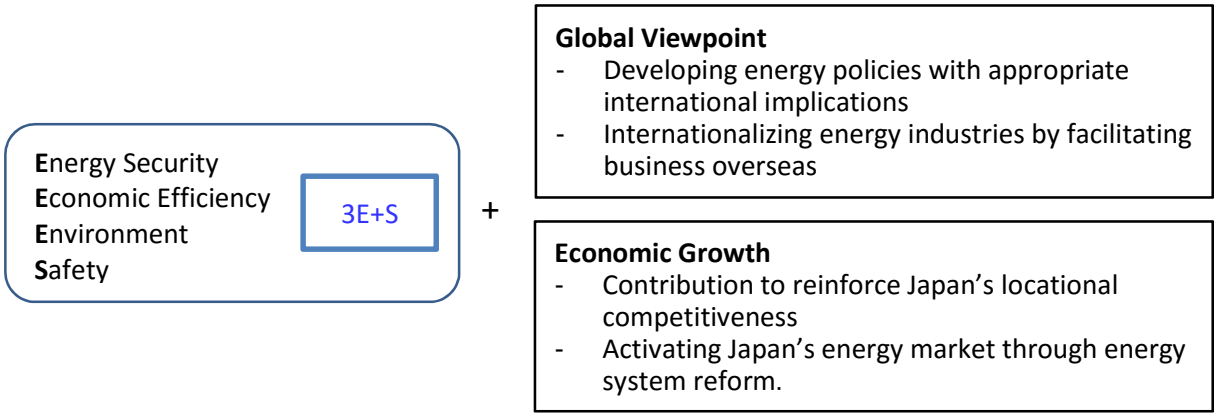
Appendix A

The 4th Strategic Energy Plan (April, 2014)[7]

(Abstract)

I. Principles of Energy Policy and Viewpoints for Reformation

(1) Confirmation of the basic viewpoints of the "3E + S" energy policies



(2) Building multilayered and diversified flexible energy demand-supply structure

- Establishing a resilient, realistic and multi-layered energy supply structure, where each energy source can realize its advantage and complement the drawbacks of other energy sources.
- Creating a flexible and efficient supply/demand structure where various players can participate and various alternatives are created by system reforms.
- Improving the self-sufficiency ratio by developing and introducing domestic resources to minimize the effect of offshore factors.

Ⅱ. Evaluation of each energy source

(1) Renewables (solar, wind, geothermal, hydroelectricity, biomass)

- Promising, multi-characteristic, important, low carbon and domestic energy sources.
- Accelerating their introduction as far as possible for three years, and then keep expanding renewables.

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[7] Source: Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry(METI).
http://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf
http://www.ewg.apec.org/documents/Notable%20Development%20Japan.EWG47.pdf

(2) Nuclear Power

- Contingent on meeting stringent safety criteria, an important base-load power source of low carbon and quasi-domestic energy source, contributing to stability of energy supply-demand structure. Providing: 1) superior in stable of energy supply and efficiency, 2) low and stable operational cost and 3) free from GHG emissions during operation.
- Dependency on nuclear power generation will be lowered to the extent possible through energy conservation and the introduction renewable energy as well as improving the efficiency of thermal power generation, etc.
- Under this policy, we will carefully consider the volume of electricity to be secured from nuclear power generation and taking Japan's energy constraints into consideration from the viewpoint of stable energy supply, lower cost, global warming impact and maintaining essential nuclear technologies and human capital.

(3) Coal

- *Revaluated as an important base-load power source in terms of stability and cost effectiveness, which will be utilised while reducing environmental load. (Utilisation of efficient thermal power generation technology, etc.)*

(4) Natural Gas

- Important energy source as a main intermediate power source, expanding its roles in a variety of sectors

(5) Oil

- Important energy source as both an energy resource and a raw material, especially for the transportation and civilian sectors, as well as a peaking power source.

(6) LP Gas

- A clean and distributed energy source that can not only be utilised in everyday life but also in emergency situations.